Predator proofing for conservation: an AWC perspective

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ABSTRACT

Australian mammals have been subject to a range of threats that have contributed to species declines and extinctions since European settlement. Invasive predators, namely the European Red Fox *Vulpes vulpes* and the feral Cat *Felis catus*, are particularly detrimental to small to medium–sized terrestrial mammals. Suppression of these predators is critical to the persistence of many native species. However, few broad–scale fox baiting programs exist in Australia and the efficacy of cat control measures is extremely limited. One of the most successful approaches to safeguarding threatened species from these impacts is the establishment of predator–exclusion areas; offshore islands or mainland 'islands' protected by predator–proof fencing. The Australian Wildlife Conservancy is a not–for–profit private conservation organisation that has established several predator–free 'islands' for conservation purposes. This brief summary of the work undertaken in these predator–proof reserves highlights how threatened species can persist and even thrive when foxes and cats are excluded, with examples from the Bridled Nailtail Wallaby *Onychogalea fraenata*, Burrowing Bettong *Bettongia lesueur* and Bilby *Macrotis lagotis*.

Key words: Conservation, *Felis catus*, invasive predators, mammals, predator–free areas, predator fencing, reintroduction, translocation, *Vulpes vulpes*

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Introduction

Australia has the worst mammal extinction rate in the world, with a third of the world's recent losses. Twenty–nine terrestrial mammal species have gone extinct since European settlement, a further 56 species are threatened and many other species have undergone massive range contractions (Short and Smith 1994; Ceballos and Ehrlich 2002; Woinarski *et al.* 2014). Eight Australian mammals persist only on offshore islands, including bandicoot, bettong and wallaby species. Some of the key factors driving these declines are invasive predators, competition with feral herbivores, habitat loss and landscape changes. Both the feral Cat *Felis catus* and European Red Fox *Vulpes vulpes* are an ongoing threat to Australian fauna. Their effectiveness as predators is linked to the potential naiveté of prey (e.g. Salo *et al.* 2007), a decline in top–order predators (i.e. Dingo *Canis dingo* and Tasmanian Devil *Sarcophilus harrisii*) (Johnson *et al.* 2007) and opportunistic hunting strategies resulting in surplus kills and caching of prey (Short *et al.* 2002).

Suppression of invasive predators is critical to the ongoing persistence of a suite of small to medium–sized mammals (McKenzie *et al.* 2007). Broad–scale fox–baiting programs in south–eastern Australian (Southern Ark) and south–western Australia (Western Shield) have been effective at reducing the impacts of foxes on some prey species. However, no equivalent landscape scale response currently exists for cats.

Translocations and reintroductions of threatened species are common conservation tools used to safeguard populations against extinction. However, the threat from invasive predators is further exacerbated in threatened species. Reintroduction attempts often fail as predation rates overtake recruitment in already reduced populations (Sinclair *et al.* 1998), with feral predation the main cause of translocation or reintroduction failure in Australia (Moseby *et al.* 2011). The IUCN guidelines for reintroductions highlight the need to mitigate the initial cause of decline before reintroductions or translocations are attempted (IUCN/SSC 2013).

Predator–free 'islands'

Given that there are very few effective landscape scale responses available to deal with feral predators and, in particular, cats, predator exclusion areas are an important tool to conserve threatened fauna. The translocation of species to feral predator–free offshore islands or to areas protected by feral predator–proof fencing ("mainland islands") has proved to be the most effective strategy in aiding the recovery of threatened small to medium–sized terrestrial mammals in Australia (Woinarski *et al.* 2014).

Australian Wildlife Conservancy (AWC) is a not–for–profit private conservation organisation with 23 wildlife sanctuaries across mainland Australia. Five of the sanctuaries across southern Australia have predator–free areas: Faure Island (4,500 ha), Karakamia (250 ha) and Mt Gibson (7,800 ha) in Western Australia, Yookamurra (1,100 ha) in South Australia and Scotia (8,000 ha) in New South Wales (Figure 1).

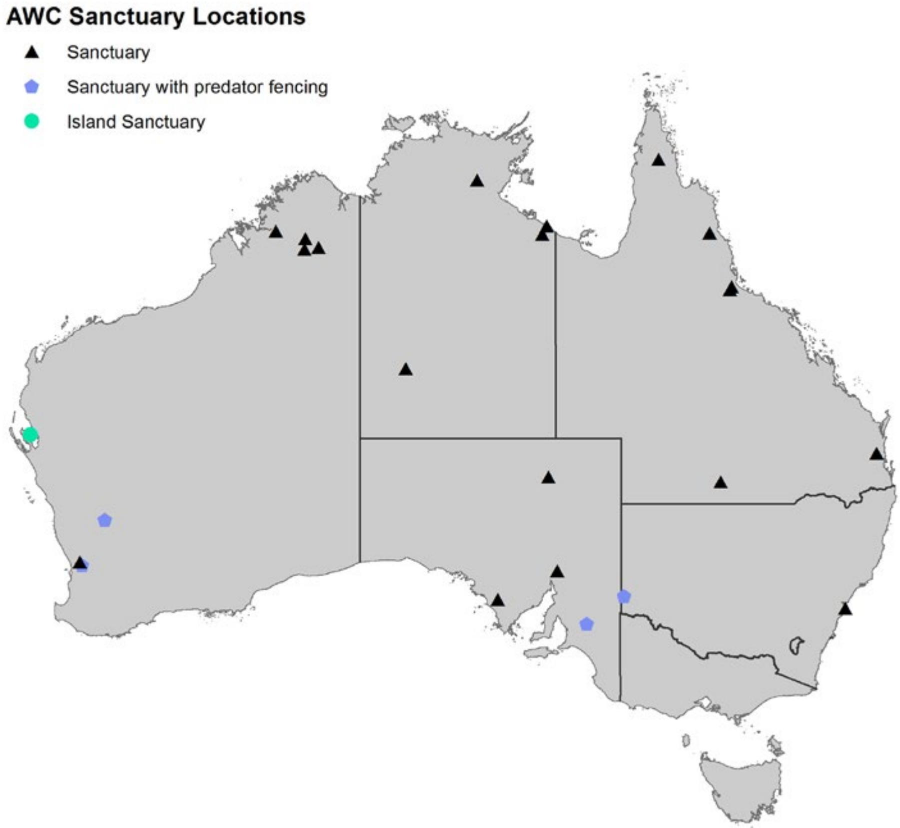
AWC Sanctuary Locations
▲ Sanctuary
⬟ Sanctuary with predator fencing
● Island Sanctuary

Figure 1. The Australian Wildlife Conservancy has 23 sanctuaries across mainland Australia, five contain invasive predator free areas.

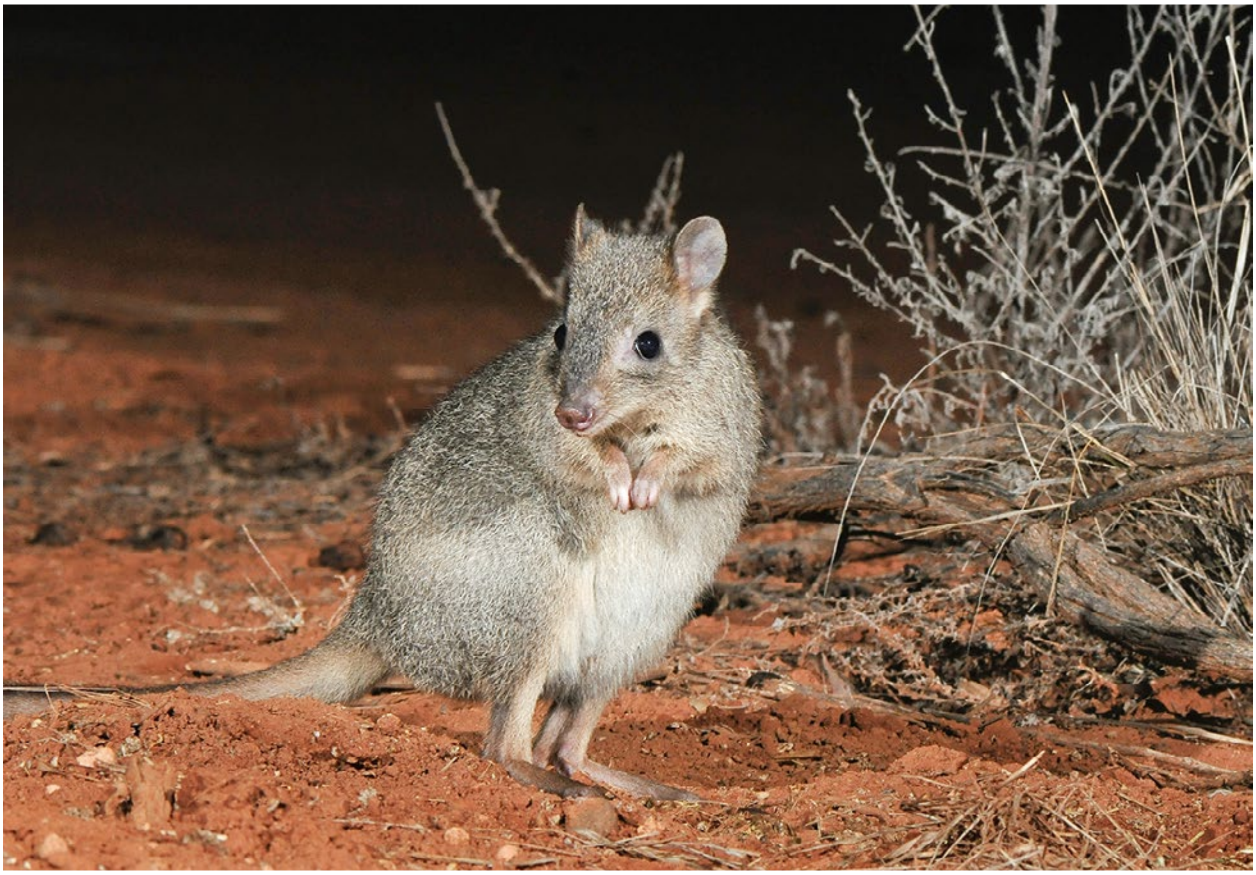

Figure 2. Brush–tailed Bettong *Bettongia penicillata* at Karakamia Sanctuary, WA (W. Lawler, photo courtesy of Australian Wildlife Conservancy ©)

Karakamia was AWC's first wildlife sanctuary, established in the early 1990s. The sanctuary supports an important population of the Brush–tailed Bettong *Bettongia penicillata* (Figure 2), which has declined dramatically in the wild in the last decade, as well as reintroduced populations of the Tammar Wallaby *Macropus eugenii*, Southern Brown Bandicoot *Isoodon obesulus* and Western Ringtail Possum *Pseudocheirus occidentalis*.

AWC acquired Faure Island pastoral lease in 1999. Following an extensive removal program, Faure Island was declared both feral predator and feral herbivore free in 2001 (Algar *et al.* 2010). At the time, Faure was the third–largest island in the world to complete a successful cat eradication program (Nogales *et al.* 2004). Prior to cat removal, native mammals had been completely lost from the island. In the past decade, AWC has reintroduced four small to medium–sized mammal species onto Faure Island: Burrowing Bettong *Bettongia lesueur*, Banded Hare–wallaby *Lagostrophus fasciatus*, Western Barred Bandicoot *Perameles bougainville* and Shark Bay Mouse *Pseudomys fieldi*.

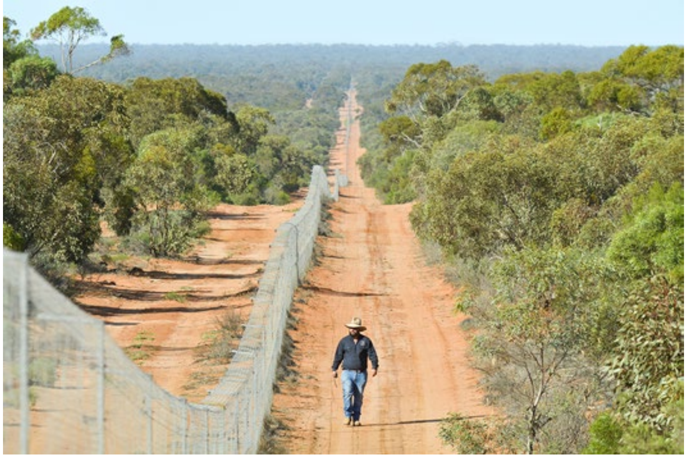

Figure 3. Scotia Wildlife Sanctuary has the largest fox and cat–free area of mainland Australia (W. Lawler, photo courtesy of Australian Wildlife Conservancy ©)

AWC acquired Scotia and Yookamurra sanctuaries in 2002 from Earth Sanctuaries and began re–construction of existing predator–proof fences and construction of new fences. At Scotia, a feral predator (fox and cat) eradication program proceeded in stages: Stage 1 was declared feral–free in 2002 and Stage 2 in 2008. Together, these stages make up the largest feral–free reserve on mainland Australia with a combined area of 8,000 ha (Figure 3). Six threatened mammal species have been reintroduced into the fenced areas: Numbat *Myrmecobius fasciatus* (Figure 4), Greater Bilby (or Bilby) *Macrotis lagotis*, Burrowing Bettong, Brush–tailed Bettong, Bridled Nailtail Wallaby *Onychogalea fraenata* and Greater Stick–nest Rat *Leporillus conditor*. Additional stages outside the fenced area have two different treatments: Stage 3 has no predator control, while Stage 4 has intensive predator control (using M44 ejectors and standard 1080 baits). The feral predator landscape–scale control in Stage 4 reduces

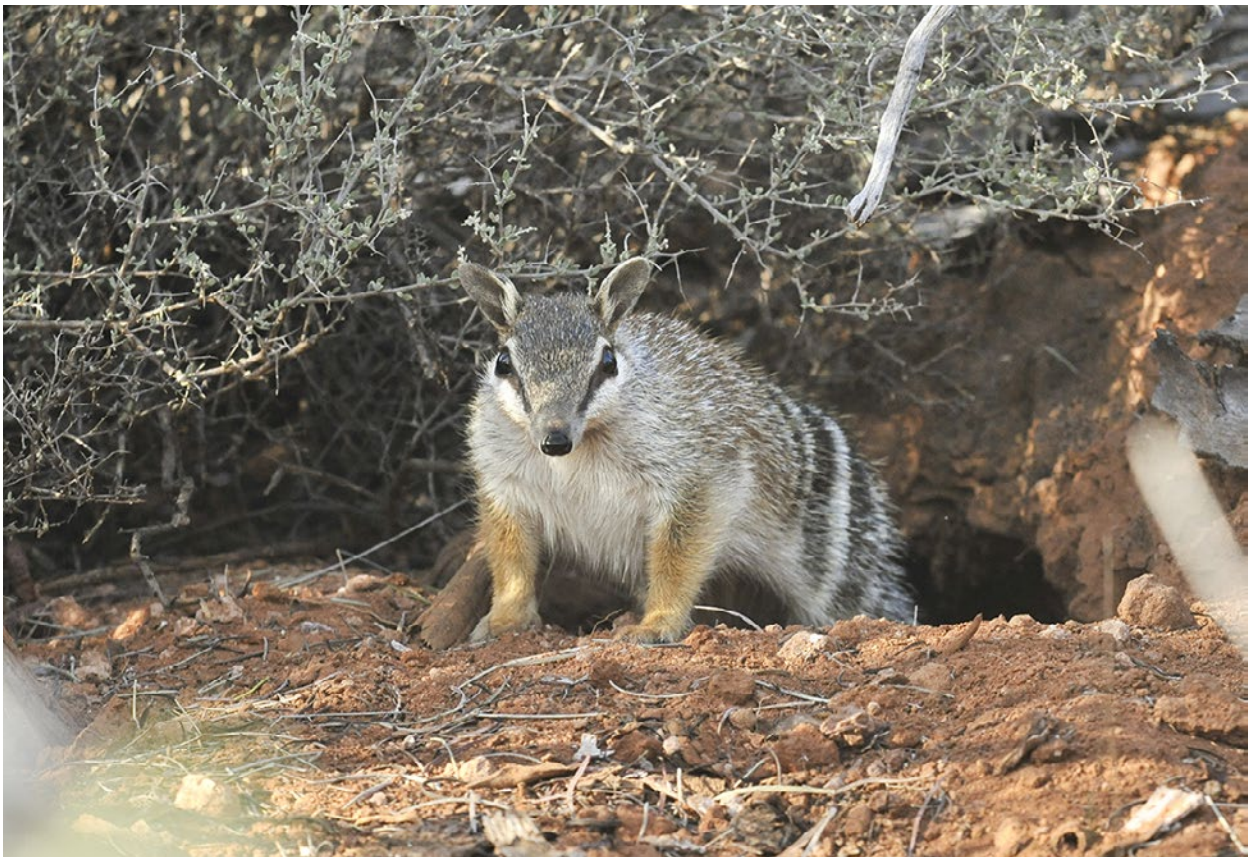

Figure 4. Numbat *Myrmecobius fasciatus* at Yookamurra Sanctuary, SA (W. Lawler, photo courtesy of Australian Wildlife Conservancy ©)

pressure on the enclosure fence while also benefitting extant species outside the fence. At Yookamurra, the fenced area supports populations of Numbats, Bilbies, Burrowing Bettongs and Brush–tailed Bettongs.

Conserving threatened species

Bettongia lesueur, a medium–sized (1300 g) marsupial from the rat–kangaroo family Potoroidae, once had the widest distribution of any Australian mammal. Now it is presumed to be extinct in the wild on the mainland and is listed nationally as vulnerable (*Environment Protection and Biodiversity Conservation [EPBC] Act 1999*). This species persists only on offshore islands and at three fenced reintroduction sites on the mainland, including two AWC Sanctuaries (Scotia and Yookamurra) (Woinarski *et al.* 2014). The main threat to this species is invasive predators (Richards 2003). Past reintroduction attempts generally failed due to the presence of feral predators, with success dependent on reintroduction sites being both fox– and cat–free (Richards *et al.* 2008). *Bettongia lesueur* was reintroduced onto Faure Island in 2002, Scotia in 2004 and Yookamurra in 2004. By 2004, Burrowing Bettongs had spread over most of Faure Island: the population is currently estimated at 5–10,000 individuals (AWC 2014). Population estimates from Scotia indicate a steady increase since reintroduction from 118 individuals in 2004 to around 1600 individuals currently; another 200 individuals are present on Yookamurra (David Roshier, pers. comm.). These three reintroductions have all been successful, as demonstrated through increasing sub–populations with reproduction and survival being at self–sustaining levels (AWC 2012). Similarly, reintroduced populations of Brush–tailed Bettongs have increased to 4,500 at Karakamia, 400 at Scotia and 100 at Yookamurra. This species has undergone a massive decline in range since European settlement, with recent catastrophic declines in remnant populations outside fenced areas in south–west Western Australia (Wayne *et al.* 2013).

The Bridled Nailtail Wallaby was thought to be extinct, with no confirmed sightings from 1937 until one remaining population was discovered in 1973 in Taunton National Park, Queensland (Qld) (Gordon and Lawrie 1980). This medium–sized macropod (4–8 kg) has undergone a dramatic range contraction, now inhabiting < 5% of its former range. This decline has been attributed to invasive predators, land clearing, habitat loss and drought amongst other factors. The species is listed as endangered (*EPBC Act*) and extinct in the wild in NSW (Lundie–Jenkins and Lowry 2005).

From the one remaining population discovered in Queensland, three more have been established, with translocations to Idalia National Park (Qld) and Avocet Nature Reserve (Qld) and Scotia Sanctuary (NSW). The reintroduction of *O. fraenata* at Avocet Nature Reserve (Queensland) in 2001 – 2005 has not resulted in a self–sustaining population, despite 14 releases of a total 166 individuals (Kingsley *et al.* 2012). This population is likely to fail due in part to cat predation on juveniles, possibly exacerbated by drought conditions (Fisher *et al.* 2001). The Idalia population has also not flourished. Total numbers in Queensland fell from approximately 1,000 individuals to an estimated 200 individuals in the decade between 2001 and 2011 (Kearney *et al.* 2012).

In contrast to the population declines seen in Queensland, numbers of *O. fraenata* have increased 30 fold at Scotia in the decade since animals were translocated to the sanctuary: the population has grown to approximately 3000 animals in 2014 (David Roshier, pers. comm.). At least 90% of all remaining *O. fraenata* now reside within predator–fencing at AWC properties. Despite attempts, reintroductions of *O. fraenata* outside the predator–proof fence at Scotia have so far proved unsuccessful, with fox predation one of the major causes of mortality within the first three months of release (Hayward *et al.* 2012).

The Bilby is listed nationally as vulnerable (*EPBC Act*) and is presumed to be extinct in the wild in NSW (Figure 5). This medium–sized mammal (1200 – 2500 g) is the only surviving member of the family Thylacomyidae following the extinction of the Lesser Bilby *Macrotis leucura* in the twentieth century. This extinction is attributed primarily to predation from the fox and cat (Burbidge *et al.* 2008). The distribution of *Macrotis lagotis* has shrunk to 20% of its former range (Southgate 1990). Now restricted to desert regions, this species is susceptible to the impacts of fox and cat predation, particularly in the 'bust' phase of the boom and bust cycle (Abbott 2001; Paltridge 2002). Numbers of *M. lagotis* are continuing to decline outside fenced areas, despite attempts at intensive feral predator control; recent estimates suggest the total number of Bilbies has fallen below 10,000 individuals (Woinarski *et al.* 2014). Again, the exceptions are to be found in reintroduced populations behind predator–proof fences; Scotia Sanctuary now supports around 1000 Bilbies; another 120 individuals are present on Yookamurra.

Many small–medium mammal species are so heavily impacted by foxes and cats that they are not present outside feral predator–free areas. However, there are a number of small mammals that persist in the wild and are capable of moving between fenced and unfenced areas at reintroduction sites. For example, the tiny (5 –14 g) carnivorous Southern Ningaui *Ningaui yvonneae* (listed as vulnerable in NSW under the *Threatened Species Conservation Act 1995*) occurs naturally in the Scotia mallee area. Capture success is higher within the Scotia Sanctuary feral predator–free areas (Stage 1 and 2) than outside the fence, even in the area with intensive feral predator control (Stage 4). Similar trends have been observed in Bolam's Mouse *Pseudomys bolami* (Leah Kemp, pers. comm.). Despite population numbers fluctuating dramatically with environmental conditions, as expected in semi–arid conditions, the exclusion of invasive predators

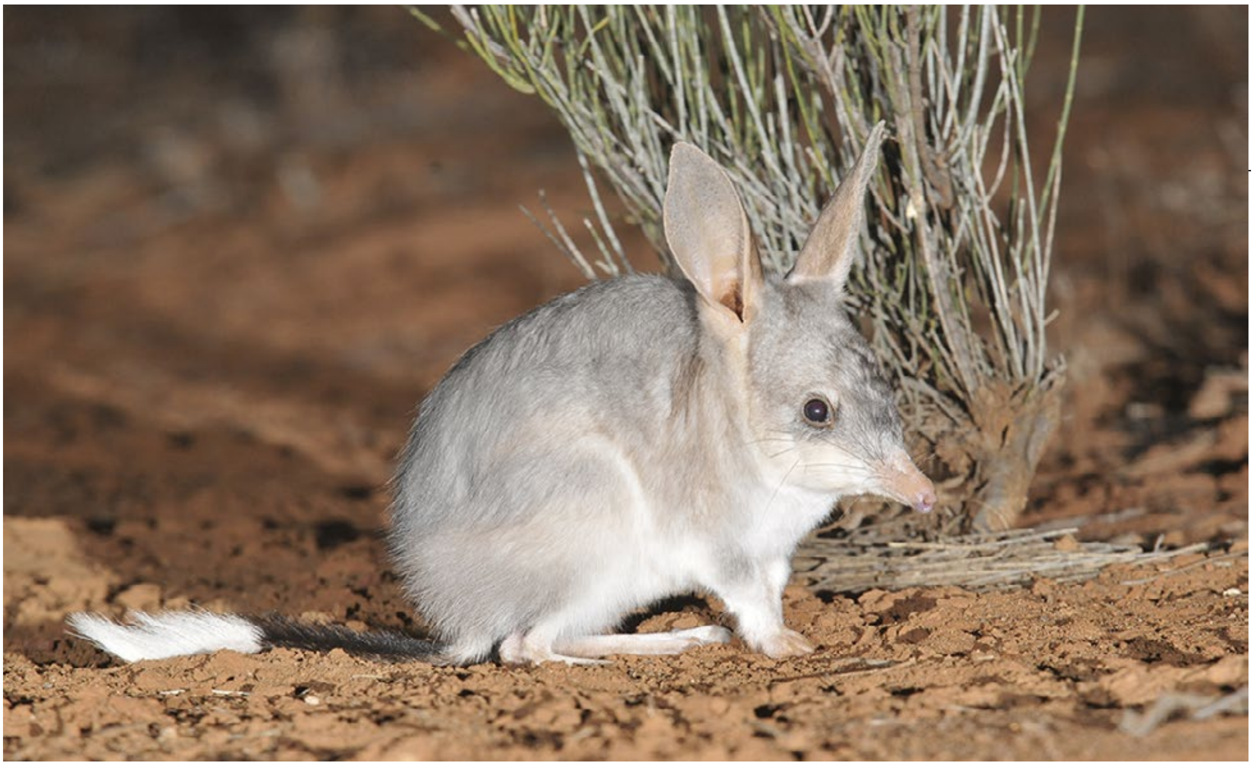

Figure 5. Greater Bilby *Macrotis lagotis* at Scotia Sanctuary, NSW (image W. Lawler, copyright Australian Wildlife Conservancy)

from the fenced area is clearly providing a net benefit to a range of small to medium–sized mammals.

Ecosystem benefits

Although the primary goal of the reintroductions conducted by AWC is to conserve threatened species, wider ecosystem benefits have emerged from several reintroduction programs. Bilbies, bettongs, bandicoots, potoroos and the Numbat have mostly declined throughout their range or have been lost from some systems. However, these digging mammals play a major role in ecosystem function as ecosystem engineers, and reintroduced species can have broadly positive impacts on the landscape (James and Eldridge 2007).

The foraging behaviour of digging mammals greatly increases soil turnover, with one estimate suggesting that a single bandicoot can displace almost four tonnes of soil per year (Valentine *et al.* 2012). The digging action of these native mammals produces narrow, deep ground depressions that act as both nutrient and moisture reservoirs (review in Fleming *et al.* 2014). This foraging strategy also increases plant and fungal community composition by promoting seed and spore dispersal and recruitment.

Management implications

One of the fundamental problems when dealing with reintroduced populations is genetic management, in particular guarding against loss of genetic diversity (Frankham 2010; IUCN/SSC 2013). This is especially relevant for populations on islands or inside predator–free fencing with limited or no immigration. However, periodic supplementation of animals may be all that is required to maintain genetic diversity of translocated populations (Ottewell *et al.* 2014). A key consideration when planning reintroductions to islands or behind predator–proof fencing is whether the area is large enough to support self–sustaining populations, or whether particular management needs to be directed to maintaining populations and their genetic diversity.

Unlike islands, fenced areas require ongoing management to maintain areas free of feral predators. Predator incursions can have devastating consequences, with a captive population of often naïve prey being highly susceptible to the impacts of predation. For example, a population of Bilbies inside a fenced area at Currawinya National Park, Qld, was exterminated by cats after damage to the fence was not detected (Woinarski *et al.* 2014). Staff on AWC sanctuaries patrol fenced areas every two – three days to ensure that these areas remain feral predator–free.

Future safe–guarding

AWC is currently establishing a new predator–free area at Mt Gibson in WA. The Mt Gibson Sanctuary is 131,710 ha with 7,800 ha designated as a feral–free area. The specially designed feral–proof fence is 2 metres high and 43 km in length. The area is currently undergoing eradication of feral animals. Nine threatened species are planned to be reintroduced: Western Quoll *Dasyurus geoffroii*, Red–tailed Phascogale *Phascogale calura*, Numbat, Bilby, Western Barred Bandicoot, Brush–tailed Bettong, Banded–hare Wallaby, Greater Stick–nest Rat and Shark Bay Mouse. These species have been selected based on their former occurrence in the region and a detailed assessment of the suitability of habitat in the fenced area. The project is expected to increase global populations of these species by 1 – 50%.

AWC anticipates that the removal of feral animals and the return of native digging mammals to the fenced area on Mt Gibson will also deliver broader ecological benefits to the ecosystem, including an increase in the richness and abundance of ground–dwelling reptiles and birds and improvements in ecosystem process such as nutrient and water retention (Fleming *et al.* 2014).

Further increases in the number, size and representation of feral predator–free areas are required to safeguard Australia's threatened mammal fauna. The effectiveness of these areas has been recognised by conservation scientists (in particular, Woinarski *et al.* 2014) and by the broader community. The need for the establishment of feral–free areas on mainland Australia was highlighted in a recent report from the Australian Senate (Environment and Communications References Committee) on the outcome of its inquiry entitled "Effectiveness of Threatened Species and Ecological Communities' Protection in Australia" http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Completed_inquiries/2010–13/threatenedspecies/report/index. It is hoped that this report will generate the impetus needed to establish further feral–free sites in strategically important areas across Australia.

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